Ergotropy Extraction Under Observational Constraints

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Coherent energy transfer in quantum systems plays an increasingly important role in emerging platforms such as quantum batteries and engineered many-body quantum systems. In this setting, ergotropy, the maximum work extractable from a quantum state via unitary operations, quantifies the operationally accessible energy stored in a quantum system. Standard formulations of ergotropy assume complete knowledge of the quantum state, allowing one to construct a globally optimal work-extraction unitary.

We instead consider the experimentally relevant setting in which one has access to many identical copies of an unknown quantum state, but only to a restricted set of coarse-grained measurements that one can perform on these copies. Such an observational constraint fundamentally limits the information we can obtain about the state and therefore the amount of extractable work. This raises the following questions: can one design an ergotropy extraction protocol that operates under restricted measurement access, and can such a protocol be realized on an existing experimental platform? In this poster, we present an observational ergotropy extraction protocol introduced in [1] and analyze the feasibility of its implementation within a trapped-ion quantum simulator architecture.

[1] D. Šafránek, D. Rosa, and F. C. Binder, Phys. Rev. Lett. 130 (2023) 210401.